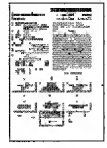
The Delphion Integrated View

Title: **JP10308289A2: COLD CATHODE TUBE LIGHTING CIRCUIT**

Derwent Title: Starter apparatus for HF drive of cold cathode tube used as backlight source of LCD panel - includes controller which performs switching of sampling of brightness controller for predetermined period from start time [Derwent Record]



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Priority Number: 1997-05-07 **JP1997000117223**

Abstract: PROBLEM TO BE SOLVED: To provide such a cold cathode tube lighting circuit as being capable of ensuring lighting of a cold cathode tube and preventing the starting malfunction.

SOLUTION: A cold cathode tube lighting circuit has an alternating current generating circuit 14 to drive a load 15 as a cold cathode tube with a high frequency, a light control circuit to control the brightness of the cold cathode tube in accordance with a light control signal LC, a control circuit 13 to control and stabilize a current in the load 15, a starting circuit 11 to control the control circuit 13 and the alternating current generating circuit 14 for generating voltage required for discharge start in accordance with a starting signal ST and an operation control circuit 16 to control the operation of the light control circuit 12.

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PATENT ABSTRACTS OF JAPAN

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(21)Application number : 09-117223 (71)Applicant : MITSUI CHEM INC

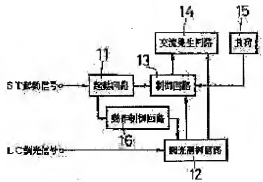
(22)Date of filing : 07.05.1997 (72)Inventor : MATSUMOTO NORIO

(54) COLD CATHODE TUBE LIGHTING CIRCUIT

(57)Abstract:

PROBLEM TO BE SOLVED: To provide such a cold cathode tube lighting circuit as being capable of ensuring lighting of a cold cathode tube and preventing the starting malfunction.

SOLUTION: A cold cathode tube lighting circuit has an alternating current generating circuit 14 to drive a load 15 as a cold cathode tube with a high frequency, a light control circuit to control the brightness of the cold cathode tube in accordance with a light control signal LC, a control circuit 13 to control and stabilize a current in the load 15, a starting circuit 11 to control the control circuit 13 and the alternating current generating circuit 14 for generating voltage required for discharge start in accordance with a starting signal ST and an operation control circuit 16 to control the operation of the light control circuit 12.



LEGAL STATUS

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CLAIMS

[Claim(s)]
[Claim 1] The alternating current generating circuit for carrying out the intermittent drive of the cold cathode tube by the RF and the "on" period of the high frequency current which flows to a cold cathode tube are adjusted. The modulated light control circuit for controlling the brightness of a cold cathode tube, and the bootstrap circuit for controlling an alternating current generating circuit so that an electrical potential difference required for discharge starting occurs at the time of starting of a cold cathode tube, The cold cathode tube lighting circuit characterized by having a control circuit of operation only for a predetermined starting period switching the intermittent control action by the modulated light control circuit to continuous action from the starting initiation point in time by the bootstrap circuit.
[Claim 2] The alternating current generating circuit for carrying out the continuation drive of the cold cathode tube by the RF and the magnitude of the high frequency current which flows to a cold cathode tube are adjusted. The modulated light control circuit for controlling the brightness of a cold cathode tube, and the bootstrap circuit for controlling an alternating current generating circuit so that an electrical potential difference required for discharge starting occurs at the time of starting of a cold cathode tube, The cold cathode tube lighting circuit characterized by having a control circuit of operation only for a predetermined starting period switching the current control value by the modulated light control circuit to controllable maximum from the starting initiation point in time by the bootstrap circuit.
[Claim 3] Said starting period is a cold cathode tube lighting circuit according to claim 1 or 2 characterized by being ten or more mses and 1 second or less from a starting initiation time.
[Claim 4] Said alternating current generating circuit is a cold cathode tube lighting circuit according to claim 1 or 2 characterized by including the piezoelectric transformer which carries out a pressure up by the interconversion of an electrical signal and mechanical oscillation.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the cold cathode tube lighting circuit for carrying out the RF drive of the cold cathode tube.
[0002]
[Description of the Prior Art] A cold cathode tube has the description that an outer diameter is thin and long lasting, and is widely applied as the back light light source and lighting fitting of a liquid crystal display panel. A high frequency drive is carried out by dozens of kHz - hundreds of kHz, and a cold cathode tube has burst modulated light and current modulated light as the brilliance-control approach.
[0003] Burst modulated light carries out the intermittent control action of the high frequency current which flows to a cold cathode tube, and controls the time average-brightness of a cold cathode tube by adjusting an "on" period. It is usually set as 100Hz or more, and brightness becomes small, so that the duty ratio of a burst wave becomes small, so that a flicker may not sense an intermittent frequency for human being's eyes.
[0004] Current modulated light carries out continuous action of the high frequency current which flows to a cold cathode tube, and controls the brightness of a cold cathode tube by adjusting the magnitude of the high frequency current. Since brightness is proportional to the power consumption of a cold cathode tube mostly, brightness becomes small, so that a current becomes small.
[0005] The lighting circuit of a cold cathode tube consists of RFs in the power circuit of the high voltage, generally has an input power terminal and a terminal for brilliance controls, and also has a thing equipped with the terminal which can control lighting/putting out lights according to an external logic signal further. The terminal for brilliance controls carries out direct continuation of the external variable resistor, or it is constituted so that the volt input of the external modulated light signal may be carried out.
[0006] Drawing 5 is the block diagram showing an example of the conventional cold cathode tube lighting circuit. The alternating current generating circuit 4 for this lighting circuit to carry out the RF drive of the load 5 which is a cold cathode tube, Based on the modulated light signal LC, the "on" period or magnitude of the high frequency current is adjusted. It consists of a modulated light control circuit 2 for controlling the brightness of a cold cathode tube, a control circuit 3 for controlling and stabilizing the current of a load 5, a bootstrap circuit 1 for controlling a control circuit 3 and the alternating current generating circuit 4 so that an electrical potential difference required for discharge starting occurs based on a seizing signal ST, etc.
[0007] The actuation is explained. If the electrical potential difference of an input power terminal (un-illustrating) reaches starting voltage, or a lighting signal is inputted and the seizing signal ST of drawing 5 becomes high-level from a low level, a bootstrap circuit 1 will operate, a pulse signal will be taken out to a control circuit 3, and the electrical potential difference more than the breakdown voltage of a load 5 (cold cathode tube) will be generated from the alternating current generating circuit 4. Since the duty of a bootstrap circuit 1 will end while discharge continues only in a control circuit 3 and the alternating

current control circuit 4 once discharge of a load 5 begins, the operating time of a bootstrap circuit 1 is usually 1 ms extent after all.
[0008] On the other hand, supposing the case where a load 5 breaks down, when the load current does not flow even in after actuation of a bootstrap circuit 1, the safety circuit (un-illustrating) for stopping the whole actuation is prepared. Furthermore, after completion of a bootstrap circuit 1 of operation, the modulated light control circuit 2 operates, the "on" period or magnitude of the high frequency current is adjusted according to the modulated light signal LC from the outside, and the brightness of a cold cathode tube is controlled.
[0009]
[Problem(s) to be Solved by the Invention] Since the electron number required for continuation of discharge is not enough immediately after discharge starting of a cold cathode tube, when it is going to perform a brilliance control immediately from immediately after starting, discharge may become unstable or may interrupt it. At this time, a safety circuit will judge with the cold cathode tube having broken down, and will stop actuation of alternating current generating circuit 4 the very thing.
[0010] Such poor starting is generated in many cases, when it is the chill whose ambient temperature of a cold cathode tube is about 0 degree C, or when the cool place is being kept without switching on the light for a long period of time. Moreover, since a liquid crystal display panel is widely used also for pocket devices, such as an electronic notebook and a cellular phone, recently, in a chill skiing area environment, we are anxious about generating of poor starting, and it is fatal when especially lighting of the back light light source is indispensable configuration.
[0011] The purpose of this invention is offering the cold cathode tube lighting circuit which can turn on a cold cathode tube certainly and can prevent generating of poor starting.
[0012]
[Means for Solving the Problem] An alternating current generating circuit for this invention to carry out the intermittent drive of the cold cathode tube by the RF, The modulated light control circuit for adjusting the "on" period of the high frequency current which flows to a cold cathode tube, and controlling the brightness of a cold cathode tube, The bootstrap circuit for controlling an alternating current generating circuit so that an electrical potential difference required for discharge starting occurs at the time of starting of a cold cathode tube, It is the cold cathode tube lighting circuit characterized by having a control circuit of operation only for a predetermined starting period switching the intermittent control action by the modulated light control circuit to continuous action from the starting initiation point in time by the bootstrap circuit.
[0013] If this invention is followed, a cold cathode tube will be turned on so that only a predetermined starting period may become the maximum brightness regardless of the brilliance-control value set up beforehand from the starting initiation time by the bootstrap circuit among controllable brightness within the limits by the modulated light control circuit. Then, when discharge is stable, it controls to become the brilliance-control value set up beforehand.
[0014] The intermittent drive of the cold cathode tube is carried out by high frequency, in the burst modulated light which controls brightness by adjustment of the "on" period of the high frequency current, a modulated light control circuit is switched to continuous action during a starting period, and after termination of a starting period is switched to an intermittent control action.
[0015] In this way, since the number of the electrons in a cold cathode tube increases quickly by driving so that only the first starting period may serve as the maximum brightness as much as possible, the stable discharge condition comes to continue and generating of poor starting can be prevented.
[0016] Moreover, an alternating current generating circuit for this invention to carry out the continuation drive of the cold cathode tube by the RF, The modulated light control circuit for adjusting the magnitude of the high frequency current which flows to a cold cathode tube, and controlling the brightness of a cold cathode tube, The bootstrap circuit for controlling an alternating current generating circuit so that an electrical potential difference required for discharge starting occurs at the time of starting of a cold cathode tube, It is the cold cathode tube lighting circuit characterized by having a control circuit of operation only for a predetermined starting period switching the current control value by the modulated

light control circuit to controllable maximum from the starting initiation point in time by the bootstrap circuit.
[0017] If this invention is followed, a cold cathode tube will be turned on so that only a predetermined starting period may become the maximum brightness regardless of the brilliance-control value set up beforehand from the starting initiation time by the bootstrap circuit among controllable brightness within the limits by the modulated light control circuit. Then, when discharge is stable, it controls to become the brilliance-control value set up beforehand.
[0018] The continuation drive of the cold cathode tube is carried out by the RF, in the current modulated light which controls brightness by adjustment of the magnitude of the high frequency current, the current control value by the modulated light control circuit is set as controllable maximum during a starting period, and after termination of a starting period is set as a predetermined current value.
[0019] In this way, since the number of the electrons in a cold cathode tube increases quickly by driving so that only the first starting period may serve as the maximum brightness as much as possible, the stable discharge condition comes to continue and generating of poor starting can be prevented.
[0020] Moreover, this invention is characterized by said starting periods being ten or more mses and 1 second or less from a starting initiation point in time.
[0021] If this invention is followed, the incidence rate (******) of poor starting can be controlled on the level which does not become a problem practically by setting the termination time of a starting period as ten or more mses from a starting initiation time. Moreover, when the timer of long duration is moreover constituted from a time constant circuit, in order to cause enlargement of components, the upper limit of a starting period has about 1 second desirable [if a starting period excels to some extent, poor starting can be prevented, but the time amount from energization initiation of a device to a user's actuation initiation is so convenient that it is short, and].
[0022] Moreover, this invention is characterized by said alternating current generating circuit containing the piezoelectric transformer which carries out a pressure up by the interconversion of an electrical signal and mechanical oscillation.
[0023] If this invention is followed, a small lightweight lighting circuit is realizable at high power conversion effectiveness by driving a cold cathode tube with a piezoelectric transformer.
[0024]
[Embodiment of the Invention] Drawing 1 is the block diagram showing one gestalt of operation of this invention. The alternating current generating circuit 14 for a cold cathode tube lighting circuit to carry out the RF drive of the load 15 which is a cold cathode tube, The modulated light control circuit 12 for controlling the brightness of a cold cathode tube based on the modulated light signal LC, The control circuit 13 for controlling and stabilizing the current of a load 15, and the bootstrap circuit 11 for controlling a control circuit 13 and the alternating current generating circuit 14 so that an electrical potential difference required for discharge starting occurs based on a seizing signal ST, It consists of control circuits 16 of operation for controlling the activity of the modulated light control circuit 12 etc. The configuration of drawing 1 is common to both burst modulated light and current modulated light.
[0025] The case of burst modulated light is explained first. In this case, the modulated light control circuit 12 performs brightness control by adjusting the "on" period of the high frequency current by the alternating current generating circuit 14 carrying out the RF drive of the load 15 intermittently. Only a predetermined starting period switches the intermittent control action by the modulated light control circuit 12 to continuous action from a starting according [the control circuit 16 of operation] to bootstrap circuit 11 initiation point in time.
[0026] Next, actuation is explained. If the electrical potential difference of an input power terminal (un-illustrating) reaches starting voltage, or a lighting signal is inputted and the seizing signal ST of drawing 1 becomes high-level from a low level, a bootstrap circuit 11 will operate, a pulse signal will be taken out to a control circuit 13, and the electrical potential difference more than the breakdown voltage of a load 15 (cold cathode tube) will be generated from the alternating current generating circuit 14. Once discharge of a load 15 begins, while discharge will continue only in a control circuit 13 and the alternating current control circuit 14, the duty of a bootstrap circuit 11 is ended. The operating time of a

bootstrap circuit 1 is usually 1 ms extent.
[0027] Furthermore, the control circuit 16 of operation works with the starting initiation by the bootstrap circuit 11, only a predetermined starting period switches the modulated light control circuit 12 to continuous action, it controls so that the brightness of a cold cathode tube serves as max as much as possible, and the warm up of a load 15 is performed. A starting period is set as the range for ten or more mses and 1 second or less from a starting initiation time.
[0028] The control circuit 16 of operation switches the modulated light control circuit 12 to an intermittent control action, and after termination of a starting period adjusts the "on" period of the high frequency current according to the modulated light signal LC, and controls it to become desired brightness.
[0029] Next, the case of current modulated light is explained. The modulated light control circuit 12 performs brightness control by adjusting the magnitude of the high frequency current by the alternating current generating circuit 14 carrying out the RF drive of the load 15 continuously. Only a predetermined starting period switches the current control value by the modulated light control circuit 12 to controllable maximum from a starting according [the control circuit 16 of operation] to bootstrap circuit 11 initiation point in time.
[0030] Next, actuation is explained. If the electrical potential difference of an input power terminal (un-illustrating) reaches starting voltage, or a lighting signal is inputted and the seizing signal ST of drawing 1 becomes high-level from a low level, a bootstrap circuit 11 will operate, a pulse signal will be taken out to a control circuit 13, and the electrical potential difference more than the breakdown voltage of a load 15 (cold cathode tube) will be generated from the alternating current generating circuit 14. Once discharge of a load 15 begins, while discharge will continue only in a control circuit 13 and the alternating current control circuit 14, the duty of a bootstrap circuit 11 is ended. The operating time of a bootstrap circuit 1 is usually 1 ms extent.
[0031] Furthermore, the control circuit 16 of operation works with the starting initiation by the bootstrap circuit 11, only a predetermined starting period switches the current control value by the modulated light control circuit 12 to controllable maximum, it controls so that the brightness of a cold cathode tube serves as max as much as possible, and the warm up of a load 15 is performed. A starting period is set as the range for ten or more mses and 1 second or less from a starting initiation time.
[0032] As for after termination of a starting period, the control circuit 16 of operation switches the current control value of the modulated light control circuit 12, and the modulated light control circuit 12 adjusts the magnitude of the high frequency current according to the modulated light signal LC, and is controlled to become desired brightness.
[0033] Drawing 2 is the circuit diagram showing an example of a cold cathode tube lighting circuit which used burst modulated light. In a bootstrap circuit 11, a seizing signal ST is first inputted into an inverter Q1 through the differential circuit of a capacitor C1 and resistance R1. The output of an inverter Q1 is connected to the collector of a transistor T1 through resistance R2. Resistance R3 is connected between resistance R2 and the base of a transistor T1, this base is grounded through a capacitor C2, and an emitter is grounded as it is. The diode D1 for antisuckbacks is connected between the collector of a transistor T1, and the control circuit 13 of the next step.
[0034] Next, in a control circuit 13, VCO (voltage controlled oscillator)21 by which an oscillation output is controlled by input voltage is formed, and the output of a bootstrap circuit 11 is supplied here. The oscillation frequency of VCO21 is about 100kHz. The I/V (current potential conversion) circuit 22 for on the other hand carrying out the monitor of the load current I of the load 15 which is a cold cathode tube is formed, and the output is also supplied to VCO21 and constitutes a feedback circuit. As for the I/V circuit 22, between the output and gland, the capacitor C5 for smooth is connected including monitor resistance and a rectifier circuit. furthermore, the output of the I/V circuit 22 -- pulldown one -- it is grounded through resistance R6 and transistor T four of business, and only a predetermined period drops the control voltage of VCO21 on zero compulsorily.
[0035] By the interconversion of an electrical signal and mechanical oscillation, including the piezoelectric transformer which carries out a pressure up, and its drive circuit, the alternating current

generating circuit 14 carries out the pressure up of the RF output from VCO21, supplies it to the load 15 which is a cold cathode tube, and generates a RF intermittently according to the "on" period of a pulse signal from the modulated light control circuit 12.

[0036] Next, in the modulated light control circuit 12, the modulated light signal LC is an analog signal by constant current, it is inputted into an inverter Q2 and transistor T3 is connected with a capacitor C4 between the input line and gland. The modulated light oscillator 20 is connected to the base of transistor T3, and the pulse of 50% of duty ratios is supplied by 100Hz - 200Hz. The output of an inverter Q2 is inputted into the base of transistor T four through resistance R7 while it is supplied to the above-mentioned alternating current generating circuit 14.

[0037] the control circuit 16 of operation -- setting -- between the input line of an inverter Q2, and glands -- pulldown one -- the transistor T2 of business is connected, the series connection of the resistance R4 and R5 is carried out between the base and gland, and a capacitor C3 is connected between the middle node and output of an inverter Q1.

[0038] Drawing 3 is the timing chart showing the actuation. Probably, before time of day t1, since the output Sa of an inverter Q1 is high-level, a transistor T1 serves as ON and the control voltage to VCO21 serves as zero, the load 15 is not operating.

[0039] Next, if a scizing signal ST becomes high-level at time of day t1, while the output Sa of an inverter Q1 will once be set to a low level and a capacitor C2 will discharge, it returns high-level again at time of day t2 in the period decided by the time constant of a capacitor C1 and resistance R1. Then, it becomes off, control voltage Vf is supplied to VCO21, and the RF drive of a load 15 starts a period and a transistor T1 until a capacitor C2 is charged. If the electrical potential difference more than breakdown voltage is impressed to a load 15 after a while from time of day t2, the load current I will begin to flow and it will be mostly stabilized at time of day t3. In addition, the load current I is a RF and is displayed with actual value by drawing 3 .

[0040] On the other hand, the signal Sb of the control circuit 16 of operation once goes up through a capacitor C3, a transistor T2 is turned on, and drops the input of an inverter Q2 near the zero compulsorily, and holds the output Sc of an inverter Q2 high-level. Then, since the alternating current generating circuit 14 outputs a continuous RF, a load 15 performs continuous action.

[0041] In order that a capacitor C3 may furthermore charge gradually through resistance R4 and R5 after time-of-day t2, the electrical potential difference of Signal Sb falls slowly, and a transistor T2 becomes off in the time of day t4 which fell from the threshold Vth decided by the electrical potential difference between base emitters of a transistor T2. Then, the modulated light signal LC is switched according to the output of the modulated light oscillator 20, the output Sc of an inverter Q2 serves as a pulse signal, and the duty ratio is adjusted according to the magnitude of the current of the modulated light signal LC. As for the alternating current generating circuit 14, since only the "on" period of an output Sc generates a RF and a "off" period does not generate a RF, a load 15 serves as an intermittent drive. Since resistance of transistor T four is set to about 0 when transistor T four is ON, the time constant of a control circuit 13 serves as a value decided by the capacitor C5 and resistance R6. Since resistance of transistor T four becomes almost infinite when transistor T four is OFF, the time constant of a control circuit 13 becomes infinite, and feedback actuation does not commit it.

[0042] In this way, after time of day t4, the brilliance control by the modulated light signal LC becomes effective, and the stable discharge comes to continue. Thus, when only the starting period specified between time of day t2 and time of day t4 switches the modulated light control circuit 15 to continuous action, positive lighting was realized and it has switched to the usual intermittent control action which performs the brilliance control based on the modulated light signal LC after time of day t4.

[0043] Drawing 4 is a graph which shows the relation between a starting period and ******. The count which did not start ****** of an axis of ordinate to the count which started the cold cathode tube is (%) comparatively, and an axis of abscissa (logarithm display) is a starting period (second) which starts a cold cathode tube by the maximum brightness. The used cold cathode tubes are the outer diameter of 3mm, die length of 250mm, and the thing of power consumption 3W, and were measured under the ambient temperature of 0 degree C, and a calm environment.

[0044] When a graph is seen, when a starting period is short, there is an inclination which ****** increases extremely, and it turns out that starting by which ****** became almost close to zero more than 0.01 second (10 mses), and the starting period was stabilized is realizable.
[0045]
[Effect of the Invention] In order for the discharge condition stabilized by turning on a cold cathode tube to continue according to this invention so that only a predetermined starting period may become the maximum brightness regardless of the brilliance-control value set up beforehand from the starting initiation time by the bootstrap circuit among controllable brightness within the limits by the modulated light control circuit as explained in full detail above, generating of poor starting can be prevented.

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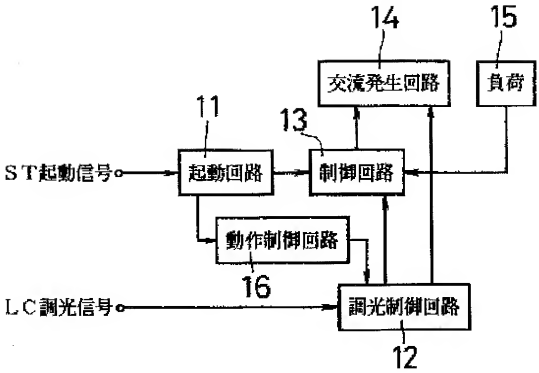
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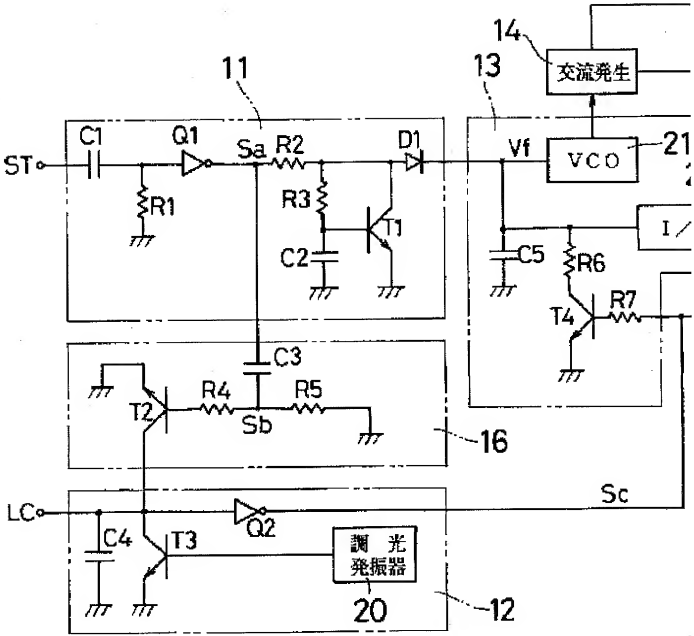
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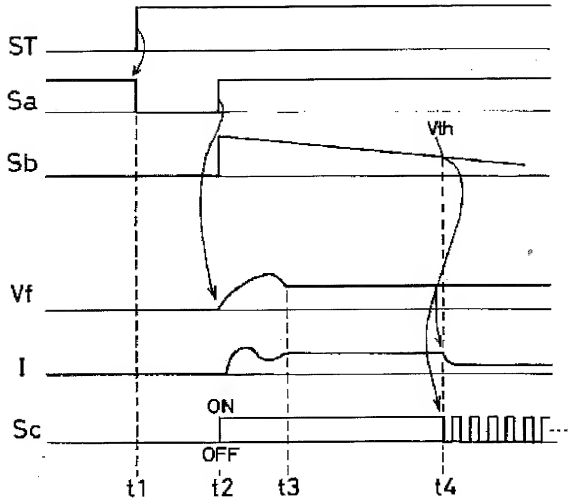
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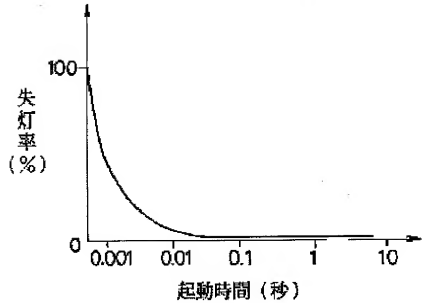
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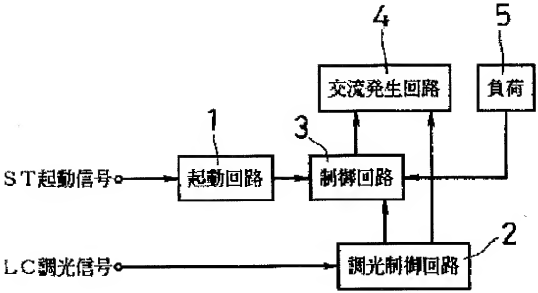
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